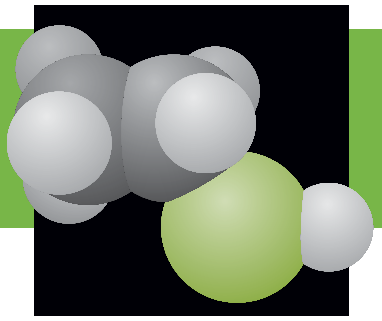
Technology Success Story

CHEMICALS



Pressure Swing Adsorption for Product Recovery

Benefits

- Potential to recover over 17 million pounds per year of olefins from U.S. polyolefin plants by the year 2020
- Energy savings of over 4,000 MW of electricity and over 8 billion standard cubic feet of natural gas annually by the year 2020
- Elimination of NO_x, CO_2, and VOC emissions through the recovery of normally flared vent streams

Applications

A single-unit PSA system capable of handling heavy hydrocarbons (c4+) is applicable to both the chemical and refining industries. This new PSA technology addresses polyolefin vent and refinery offgas streams and can be adapted to recover valuable products from other waste streams throughout the industry.

Highly Selective Pressure Swing Adsorption (PSA) Technology Recovers Valuable Components from Waste Streams

Recovery of olefins from polyolefin plant vent gases can improve productivity and reduce energy use. Current methods for polyolefin recovery typically begin with compression of the low-pressure waste vapor stream consisting largely of nitrogen with ethylene or propylene. The compressed vapor is then chilled to cause olefin to separate from the nitrogen as a condensed liquid. This technique is reliable for removing 60 to 90 percent of olefin from waste vapor; however, the remaining nitrogen commonly retains a certain amount of olefin (usually several percent). The nitrogen and olefin mixture must be combusted to convert the remaining olefin to CO_2 and water vapor before being released into the atmosphere. This combustion process results in emissions of NO_x, VOC, and CO and sometimes requires the addition of natural gas to achieve sufficient combustion.

An alternative method, employing pressure swing adsorption (PSA), provides an energy-efficient and economical method for recovering these components in a single-unit operation. PSA uses the attraction of organic molecules (such as olefins) to certain inorganic materials (adsorbents) to remove the molecules from waste streams. When the nitrogen and olefin mixture is exposed to an adsorbent at high pressure, the olefin separates from the nitrogen by collecting on the surface of the adsorbent. When the pressure is reduced, the olefin releases from the adsorbent as a concentrated vapor. This process can be repeated over and over using the same adsorbent.

Four Bed Pressure Swing Adsorption Unit

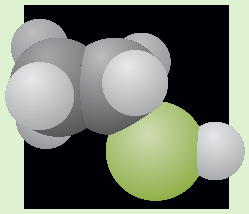
A recently constructed four bed pressure swing adsorption unit. One bed produces clean product gas by removing the hydrocarbon components from the feed gas while the other three beds are in various stages of regeneration.

Project Summary

The project partners combined the advantages of vapor compression and partial condensation processes with the unique capabilities of PSA to create a single unit capable of converting 100 percent of the nitrogen waste stream into reusable products. The system uses four pressure vessels, or "beds," containing small beads of solid adsorbents. Nitrogen contaminated with olefins is passed through a first bed, which removes the olefin from the gas and produces the reusable nitrogen product. When the adsorbent in the first bed holds its limit of olefin, the nitrogen waste stream is passed through a second bed. Meanwhile, the "loaded" first bed is regenerated, recovering the olefin in a low-pressure vapor. The olefin-containing stream passes through the compression step that initially compressed the waste gas feeding the system and is converted into pure olefin liquid. Pure nitrogen and pure olefin leave the system for reuse in the polyolefin manufacturing process. The waste stream is completely converted into reusable products, no combustion is used in the process, and no emissions are released into the atmosphere. All four beds are used simultaneously in various stages to create a continuously operating system.

Commercialization

Two commercial applications of the PSA technology are underway, with more expected in the near future. In early 2002, the Chevron Phillips Chemical Company purchased and applied the system for the first time commercially in its polyethylene facility in Cedar Bayou, Texas. A second system was purchased by a polypropylene producer in the Texas Gulf Coast area for recovery of propylene and nitrogen. This second system is currently under construction, with an expected start-up date in late 2003.



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